SMALL DEVELOPMENT PROJECTS

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Promoting safety leadership in higher education: The role of principal investigators

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Small Development Projects

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Executive Summary

Background information

Recent safety incidents involving explosives in UK and US university laboratories have highlighted the need to pay greater attention to the status of safety within research settings. Research teams have unique power dynamics with the academic futures of graduate students and research staff greatly dependent on their principal investigator (PI). Hence, PIs are essential in challenging and overcoming old assumptions and in moving universities towards a strong, positive safety culture. However, little is understood about how to develop PIs' engagement in safety leadership. This research provides insights into what effective PI safety leadership entails and the factors that either foster or hinder PIs' engagement in safety leadership.

The study focused on PIs because they hold an important intermediary position between senior leadership (such as deans, heads of school) and frontline research staff and they have the potential to directly influence the safety perceptions and behaviour of research group members. Moreover, PIs face unique challenges in their leadership role: for example, they may have been required to step into a leadership position with limited opportunity to gain leadership experience prior to becoming PI, and they may be leading research teams that last only the duration of a specific project.

The key aims of the project were to:

(1) Explore PIs' perceptions about their role as safety leaders.
(2) Investigate which specific leadership practices PIs use for enhancing safety.
(3) Identify factors that facilitate and hinder PI engagement in safety leadership.

An important objective was to understand how safety can be incorporated into PIs' wider leadership approach. We identified the SAFER leadership framework by Wong, Kelloway, and Makhan (2016) as a conceptual foundation to guide our research. It conceptualises five core leader behaviours: speaking about safety; acting safely; focusing on safety standards; engaging others in safety initiatives; and recognising safe performance at work.

Analysis and findings

One-to-one interviews were conducted with 26 PIs from two UK universities (one research-intensive institution and one institution pursuing research-intensive status). Interviews followed a semi-structured format. Interview transcripts were analysed using an adaptation of Braun and Clarke's (2006) thematic coding.

The main findings in relation to the project's aims are summarised below.

Aim 1: To explore PIs' perceptions about their role as safety leaders

Interview results indicated that PIs tended to approach responsibility for safety as a *prevention* of negative events or a *promotion* of safety as an ongoing, active initiative. Some PIs viewed responsibility for safety as non-applicable in their research area, indicating the need for institutions to provide domain-specific safety communication that applies safety to particular research areas.

Aim 2: To investigate which specific leadership practices PIs use for enhancing safety

The most frequently described safety leadership practices included regularly speaking about safety in formal settings (eg research group meetings) and informal conversations and role modelling with regards to safety. One way in which PIs seemed to integrate safety into their wider leadership was by taking an "ethical leadership approach" (feeling responsible for the development of staff); being generally caring towards their research staff, including their physical safety; and providing research group members with a "bigger picture" to maximise their potential for contribution, including regarding risk and safety.

Aim 3: To identify factors that facilitate and hinder PI engagement in safety leadership

Development was discussed by several interviewees as a way to facilitate PI engagement in leadership. Informal development through learning from others and learning from experience was regarded as suitable for the PI role. Some PIs reported a lack of opportunity for exchange with peers about the PI role. It was emphasised that formal development should be led by individuals with an understanding of the academic environment.

Some PIs noted that safety in the higher education sector is not given the same value as in their disciplines' respective industry sector. Such perceptions could be a hindrance factor for PIs' engagement in safety leadership, and lead to acceptance of lower safety standards.

An online 'PI and research team' survey was also undertaken at the first, research-intensive UK university as part of this study. However, it yielded a sample that was too small to produce robust results and so we did not proceed with the analysis of the survey results at this stage.

Conclusion

The findings from the interview study have generated recommendations for institutions on the implementation of PI safety leadership development programmes, and provide guidance for PIs themselves on how to promote safety effectively. For example, the importance of informal development opportunities alongside formal development was highlighted as an avenue to facilitate PI engagement in safety leadership. Making safety specific to research areas, especially in scientific domains where risk is low to moderate or when high risk activities are rare, was identified as important, along with framing safety as an ongoing, active initiative and creating positive goals rather than focusing merely on prevention of negative outcomes. ■

01 Project aims

This project aimed to identify what practices university leaders adopt to increase the safety culture of their research team and institution, and how university leaders' engagement in safety can be enhanced. The study focused on principal investigators (PIs) as a group that, so far, has received limited attention in terms of their ability to create safer institutions.

Recent incidents involving explosives in UK university laboratories and safety incidents at US universities with severe consequences (eg the Texas Tech incident in 2010, when an explosion in a chemistry lab seriously injured a graduate student), have highlighted the need to pay greater attention to the status of safety within research settings. Research teams have unique power dynamics, with the academic futures of graduate students and research staff greatly dependent on their PI. Hence, PIs are essential in challenging and overcoming old assumptions and moving universities towards a strong, positive safety culture. However, little is understood about how to develop PIs' engagement in safety leadership. This research provides insights into what effective PI safety leadership entails and factors that either foster or hinder PIs' engagement in safety leadership.

PIs are in a unique leadership position as they are often responsible for leading research teams of considerable size, but usually have progressed to their PI position through academic achievements and with limited or no previous management experience or training in leadership competencies. In addition, their role is often temporarily constrained to the duration of a research project. Once a research grant has been successful, they are required to step into their PI position "ad hoc". Moreover, with regards to safety, PIs are not in a formal safety role (such as health and safety managers or safety advisors), yet are required to put their institutions' safety policy into action and develop a safety culture. Safety research in other sectors, such as construction, oil and gas, has identified frontline leaders as critical to shaping an organisation's safety values and norms (O'Dea and Flin, 2001; Griffin and Hu, 2013; Kapp, 2012). Drawing on social learning theory (Bandura, 1977), frontline leaders convey the value of safety through their repeated interactions with employees. Thus, PIs are in a pertinent position, having close proximity to individuals working in safety-critical situations (eg graduate students and research staff) and act as an intermediary in the upward flow of safety information. Therefore, this project investigated what constitutes effective leadership at the PI level.

The project also specifically focused on trying to understand what fosters and hinders PIs' engagement in safety leadership. As outlined above, a PI's role does not specifically focus on safety – which means that there is considerable latitude over the extent to which PIs choose to engage in leadership activities that are safety related and how they integrate safety into their broader leadership objectives. Hence, it is important to understand how PIs can incorporate safety leadership as an integral part of their wider leadership efforts.

In summary, the study aims are to:

1. Explore PIs' perceptions about their role as safety leaders.
2. Identify specific leadership practices that PIs use to enhance safety culture and safety performance.
3. Understand factors that facilitate or hinder PIs' engagement in safety leadership. ■

Project approach and activities

Review of the safety leadership literature

Prior to starting the data collection, we reviewed existing literature on safety leadership. Research on safety leadership has mainly focused on sectors such as construction (eg Conchie, Moon and Duncan, 2013), trade (eg Mullen, Kelloway and Tweed, 2017), healthcare (eg Halbesleben et al, 2013) with studies in the education or research environment being absent. This lack of studies in higher education reinforced the need to examine safety leadership in a research/education environment. Nevertheless, the research from other sectors provided evidence that leaders at all levels, including frontline positions, are relevant for influencing safety (eg Griffin and Hu, 2013; Jiang and Probst, 2016; Kapp, 2012).

We identified the SAFER leadership framework by Wong, Kelloway, and Makhan (2016) as a conceptual foundation to guide our research. The SAFER leadership framework was developed from existing empirical research and conceptualises five core leader behaviours: speaking about safety; acting safely; focusing on safety standards; engaging others in safety initiatives; and recognising safe performance at work. In particular, with regards to Project Aim 2 (identifying leader practices for safety), we explored whether these five core behaviours identified in other sectors are also effective for safety leadership in higher education.

Study design

Qualitative study

We adopted a qualitative approach to exploring PIs' experience and views on leadership and safety in the PI role. The initial study design planned to hold focus groups with PIs. However, it became clear that the requirement for PIs to attend a focus group on a set date and time would hinder participant recruitment. Moreover, following a first trial focus group, it became apparent that focus groups might not provide an optimum space for individuals to share openly their experience as PI and views on safety leadership. Other participants might be staff from their same working group/ department, including colleagues from higher-level positions. Although participants were assured that all responses are treated with strict confidentiality, this could make participants reluctant to share openly their experiences and views. It was therefore decided to conduct one-to-one interviews with PIs instead, and the study design was amended accordingly. The data collection procedure for interviews with PIs is outlined in section 3.4.

Quantitative study

Guided by the findings of the interview study, a quantitative survey was developed to further examine how PI leadership practices influence the safety behaviour of research team members. The survey includes measures on:

- PIs' *ethical leadership* as perceived by their research group members.
- PIs' perceptions of the *ethical climate* in their university.
- PIs' *initiative for safety*.
- PIs' views on *responsibility* for safety.
- Research groups' *safety compliance* and *proactive safety practices*.

The interview study revealed that one way through which PIs integrate safety into their wider leadership effort is by placing ethics at the centre of their leadership approach, such as a genuine focus on care and concern for others, transparency and integrity. Moreover, the results from the interview study also indicated that the wider university climate was a factor that can facilitate PIs' engagement in taking a proactive approach towards safety. Thus, in the quantitative survey we investigated to what extent PIs' *ethical leadership* influences the *safety* compliance and *proactive safety behaviour* of research group members, and whether a strong, positive *ethical climate* can strengthen such relationship. In addition, three safety incident scenarios were developed for the survey based on real-life accidents. The scenarios assessed who PIs view as responsible for influencing safety outcomes, and whether PIs frame *responsibility for safety* more as a *prevention*-perspective concerned with avoiding negative events (eg accidents) or a promotion-orientation focused on fostering safe action. The aim was to test whether promotion- or prevention-oriented approaches are linked with a stronger *initiative* for safety.

In summary, based on the interview study, the survey examined the following research questions:

1. Does PI ethical leadership have a positive effect on research members' safety compliance and proactive safety behaviour?
2. Does the university's ethical climate augment the influence of ethical leadership on research group members' safety behaviour?
3. Is PI ethical leadership related to PIs' perceptions of responsibility for safety?
4. Do PIs with a promotion-oriented regulatory focus (rather than a prevention-oriented focus) display greater safety initiative?

To avoid self-rating bias, responses were collected from research group members as well as their PIs. Research group members were asked to rate to what extent their PI exhibits certain ethical leadership behaviours (eg "My PI can be trusted to do things he/she says", "My PI holds me responsible for things that are not my fault").

PIs rated how they perceived the university's ethical climate (eg "In this university, people are mostly out for themselves"), their own initiative for safety (eg "I often make suggestions to improve how safety is handled around here") and provided ratings for the safety performance (compliance and pro-active safety behaviour) for three research members (eg "This person puts in extra effort to improve safety"). Asking PIs to provide individual ratings for all research group members was not feasible as research groups can be very large. Instead PIs were instructed to nominate three research members. An online survey workflow was developed where PIs complete the survey and nominate three research members who were automatically invited to complete the survey. This online workflow allows matching of the responses from PIs and their research group members. Figure 1 illustrates this workflow. The complete questionnaires for PIs and research team members are available upon request from Dr Sara Willis.

Figure 1. Survey data collection process

Ethical approval

The qualitative part of the project was formally reviewed by Alliance Manchester Business School's Ethics Signatory with recommendation that the study does not require ethical review by the University Ethics Committee. Ethical approval was obtained for the quantitative part from the University of Manchester [approval reference AMBS-2016-003].

Data collection procedure: PI interviews

Access was arranged to conduct the interview study at two universities. University 1 is a research-intensive institution; University 2 is currently engaged in strategies with the aim of becoming a research-intensive institution within the next five years. Access to a third university was recently secured and interviews there will begin this autumn. This report will outline findings from the interviews at University 1 and University 2. A number of different universities were approached to participate in the survey, but access could not be arranged.

We invited academic staff who are in a PI position or have been a project PI in the past five years to take part in the study. At University 1 emails were sent to PIs across all faculties. At University 2 emails were sent only to PIs in computing and engineering, due to limited access. The email invitation and accompanying information sheet outlined that the study focuses on "PI leadership", but did not mention the project's focus on safety explicitly. One reason for this was to avoid a self-selection bias that could lead to a sample that mainly represents PIs who are engaged and proactive in the area of safety. A further reason was that the research aims to investigate how PIs can integrate safety efforts into their overall, wider leadership role. Inviting participants specifically to an interview on "safety leadership" might limit their responses. Following the initial invitation email, two reminder invitations were sent. In total 257 academics were invited to the interview study. Twenty-six PIs responded to the invitation (22 at University 1 and four at University 2). Interviews were scheduled at a time convenient for participants. Interviews were conducted by the researcher and the project's research assistant. The majority of interviews were conducted face-to-face with a small number of telephone interviews. Interviews were voice recorded and later transcribed verbatim. Prior to deciding whether to take part, participants were informed that interviews will be recorded and that all quotes used in dissemination will be anonymised. Individuals who decided to take part gave written consent.

Interview schedule

Interviews followed a semi-structured format. The interview schedule was developed based on the research aims and literature review. The full interview guide is available in Appendix 1. Interviews began by asking participants to describe their area of research activity and to outline an example of a project where they have been PI. Interviews then continued by asking participants to describe what defines good PI leadership. Prompting areas included inviting participants to elaborate on specific competencies or to provide examples of how a PI contributed to the success/failure of a project through their leadership. Interviews then became more specific, asking participants to describe what defines good PI leadership for "responsible research" and, subsequently, participants were asked to describe what defines good PI leadership for "safe research". Safety leadership was further explored by asking participants to describe factors that help and hinder PIs to engage in leadership for safe research. This approach of leading participants from more general leadership questions to safety leadership, specifically, allowed the topic of safety to emerge organically in the conversation. Asking participants straight away about "safety leadership" might narrow their approach to the interview discussion. Moreover, given that safety is a concept that is highly socially desirable, asking participants directly about their efforts to lead on safety is likely to distort responses. The interview ended by asking PIs about the most important development needs for PIs. Interviews closed with a participant debrief.

Data collection procedure: PI and research team survey

The survey was distributed at University 1 to PIs within the disciplines of chemistry, chemical engineering, computer science, environmental science, physics, astronomy, mathematics, materials, and engineering.

An email invitation was distributed to all academics in the above disciplines who are currently a PI or have been a project PI in the past five years. Three reminder emails were sent after one, three and four weeks. Six weeks following the initial email, the faculty dean sent a message to encourage participation in the study. In total 312 academics were invited to take part of which 32 PIs completed the survey and 16 research group members provided responses about their PI's leadership. This low response rate at 10% and subsequent small sample size impedes the representativeness of the results. ■

02 Findings

Results: Interview study

Interview transcripts were analysed using an adaptation of Braun and Clarke's (2006) thematic coding using Nvivo 11 software. Thematic coding allows us to identify patterns of meaning within the PI interview data and systematically review such themes. A sample of 12 interviews was selected for cross-coding by two separate coders who both had an academic background in safety leadership.

A summary of some of the main findings in relation to the project aims is presented below. This analysis is based on the 26 interviews from two UK universities.

Aim 1: To explore PIs' perceptions about their role as safety leaders

Perceptions about the PI role (general)

One objective of the project was to understand how safety is incorporated into PIs' overall role. It was therefore important to understand how PIs construe their role in general before taking a safety-specific focus. One of the most frequent themes that emerged in participants' descriptions of their PI role was related to being a "project manager". This involved actions such as coordinating staff, liaising with research partners, recruitment, managing budgets and timelines. There was a tendency for participants to perceive their role as a meta position rather than one that is directly involved in the operational research. A second meaning that emerged was around being a scientist and involved aspects such as developing an original idea and having a scientific vision. This theme was less frequent than the "project manager" theme, and was often discussed in combination with management aspects. A prevalent idea that emerged from the interviews was that an effective PI is one who combines these two aspects - science and management - successfully.

A further theme that emerged was labelled "developer of others" which describes a sense of responsibility to develop others in their scientific careers, such as graduate students and research assistants. This part of the PI role tended to be framed in a positive way as one that provides satisfaction. Although safety was rarely mentioned explicitly, PIs spoke about developing "the right attitude in the lab", developing research capabilities and challenging assumptions of others. Being responsible for developing others' attitudes, abilities and assumptions about how to conduct research holds relevance for addressing safety within the research process. Given that development of others was frequently perceived as a positive, satisfying part of the PI role, this could be an effective place to incorporate responsibility for safety into the PI role.

Table 1. Perceptions about the PI role (non-safety specific)

Theme	Sample quotation
Project manager	*"I think someone that can have an overview of what the project needs, but doesn't get caught up in the fine detail. And that should be done by the researcher. But in a supportive environment, so it's not being hands-off, it's being there and understanding all the different components of the project in terms of what methods need to be done, timing, how the budget's being spent, liaising with the other research team members."*
Good science – good management combination	*"You can be a very bad manager and you still have a very good vision and that's a funny combination, but that happens a lot actually."* *"If you don't have a vision as a PI then the project can be administratively successful, successful in terms of the individual components but perhaps - I wouldn't call it mediocre - but perhaps again it's one of these cases where it could have been much better."*
Developer of others	*"So, it has been a lot of mentoring the student, pointing him in the right direction in terms of basic reading, basic understanding of the science. The right attitude to have in the lab, following up also on his analysis, his day to day work, but also on the global picture and the global aim of his research. And also offering him a chance to grow as a scientist and as a researcher, by giving him enough freedom, yet enough guidance to still be on track for his research."* *"I think you get more out of people if they are, sort of, the project is well aligned to their own career development. That's one of the things that I think is important to think about people as people who are developing their careers."*

Perceptions about the PI role (safety-specific)

Responsibility for safety within the PI role was not explicitly raised by PIs when asked about "good PI leadership" in general. When probed directly about safety leadership, most PIs expressed that this was part of the PI role. However, views varied on the drivers for taking responsibility and how responsibility should be enacted. Some PIs focused more on a moral/ethical perspective while others gave more emphasis to legal obligations with combinations of these two being common. Two main categories emerged from PIs' views about how responsibility for safety is to be implemented. These were consistent with prevention-orientation and promotion-orientation regulatory focus (Crowe and Higgins, 1997). Prevention-orientation was focused on meeting rules and avoiding unsafe behaviour.

An extreme form of a prevention-oriented focus was reported by a small number of PIs who explained that they did not engage in safety as the risks in their research domain were so low that there was nothing to prevent. In these cases, PIs viewed responsibility safety as "non-applicable" in their area of research. This suggests that it is important for institutions to use domain-specific safety communications. In particular, demonstrating how safety applies in areas where risk tends to be low to moderate is important for PIs to be able to make sense of safety communications and understand how responsibility for safety is relevant in their respective field. A promotion-orientation was focused on promoting safety beyond minimum requirements and represented safety as an active, ongoing initiative.

Table 2. Perceptions about the PI role (safety- specific)

Theme	Sample quotation
Drivers of safety leadership	*"Otherwise, if something were to happen, it then becomes an issue as to whose responsibility it is, and it's usually not necessarily the person who was actually doing the piece of work at the time, it's the leader who ultimately takes responsibility and if they haven't instructed and provided clear guidance and so on, then they will be the ones at risk."* *"You have moral and ethical obligations. You have professional, you know, obligations and you also have the threat of litigation or legal procedures if you're not doing what you should be doing and you're found to be negligent or even worse. For me that's what would drive it, but the moral and ethical ones come first."* *"I hate to say it, but I think having clear guidelines and paperwork and so on to do, because otherwise unfortunately there will be some PIs who won't keep on top of it. […] I think having a culture where PIs recognise that they are ultimately responsible for what goes on within their environment."*
Responsibility for safety	**A. Prevention-orientation** *"Well I would say that on the ethical one it's more on – I mean it sounds administrative because it's basically don't do that, don't do that, don't do that, or if you do this, do this as this is following the rules – that's not much more than you can do apart from just checking that everyone is following the rules."* *"You know, at the end of the day what the PI can do if someone is doing something wrong is just check that everyone is following the rules because it comes to rules, you know."* *"So safety's something we don't really think about. We've got people here, we're all sort of desk jobs, risk of a paper cut. But personally I think we do very badly and I think that should be something we think about a bit better."* **B. Promotion-orientation** *"The university has some rules in place, you know what I mean, how we deal with our students, how we keep things. […] Those are the meaning things, kind of ticking boxes if you want. The PI can do that much more than that, do you know what I mean, you don't need to do it every week, once a month. I mean come on, but that will depend on the PI okay and the person and how you manage your people.* *It's entirely your role, to put the importance in how you think it is appropriate – that's it. I don't think there is any limitation whatsoever, it's just the imagination or what the PI thinks is more important."*

Aim 2: To identify specific leadership practices that PIs can use to enhance safety

Consistent with the SAFER leadership model (Wong, Kelloway and Makhan, 2016), PIs reported behaviours related to speaking about safety; acting by example; and focusing on maintaining safety standards. There was less emphasis on the final two dimensions of the SAFER leadership model: engaging others in safety and recognising safety performance. Engaging others and recognising performance were mentioned as important in relation to other parts of the research process (eg dissemination), but emerged much less with regards to safety leadership. When participants were asked to describe effective leadership (without a prompt to think about safety specifically) and effective leadership for responsible research, practices related to being available and approachable, demonstrating integrity, clarifying expectations, ensuring fairness, being able to see the bigger picture, demonstrating concern for others, and considering ideas from others were reported as important. These practices were consistent with ethical leadership theory (Brown and Treviño, 2006) and often connected ethics, safety, wellbeing of staff and research outcomes (eg publications) to an overall purpose of the research. One objective of the project was to understand how safety can be an integral element of PI leadership, without being perceived as a separate "add-on". If PIs connect across different parts of a research project by taking an ethical leadership approach, this presents a useful strategy through which PIs can integrate safety into their wider leadership efforts.

Table 3. PI safety leadership practices

Theme	Sample quotation
Ethical leadership	*"So I think ineffective leadership is not having that first discussion with your RAs, not making sure that they do understand why they are doing the research, what the purpose of it is, and what your aims are, and then just leaving them to get on by themselves, leaving things to the last minute, not giving them the bigger picture, the longer-term plans as well as the shorter-term plans, as well, and not letting them know how the data will be used, how you will report it."*
Safety-specific leadership	**A. Speaking about safety** *"Just by ensuring there is always an item [on safety] there you can hope that at least people will recognise that as something that has to be borne in mind all the time."* *"You know, I've been here now for, what, 20 months or so, and I've never had – unless nobody's invited me to one, which again would be very odd – a staff meeting where health and safety would be on the agenda, whereas it was the norm in the previous institution for there to be a monthly academic staff meeting of which health and safety was on the agenda. That might have been that there wasn't anything to report, but it was there, it was an opportunity for health and safety managers to highlight key issues that there might be, it was an opportunity for staff to raise any issues they might have on it."* *"And I think the main thing is, as I say to all of them, is if you are ever in any doubt, ask, don't just go ahead and do something if you're unsure about it. Even if it's relatively trivial, I'd much rather you asked a senior member of the team than went ahead and did something which would then have some consequence down the line which would be complicated for all of us."* **B. Acting by example** *"It's culture, once people start doing things the right way, they naturally do it the right way. […] so I don't walk into the lab without PPE [Personal Protective Equipment] on. If I did and people saw me do it, then they wouldn't put it on. You've got to, even if it's a pain […] which it is if you're just going in there to talk to someone, you've got to always follow the rules yourself."*

Continued

Safety-specific leadership	**C. Focusing on maintaining standards** *"It's an attitude, you have to put it first at all times. You can't say, oh we need this result desperately to publish a paper or something like that, therefore forget about such and such a rule. Safety always has to come first and if you can't do something because of safety you can't do it."* *"That was an example of unsafe research. And behind that you had managers who were, if not encouraging workers to deviate from health and safety precautions, they were at least condoning it, and bringing in these commercial incentives to get this experiment done and to get round safeguards and protocols. So not doing that. I guess a good PI wouldn't get involved in that."* **D. Engaging others in safety** *So it's kind of encouraging people to think about safety themselves, but also keep an eye on what they are doing, and if you think that people might start working in unsafe ways then discourage that and promote safe working."*

Aim 3: To understand factors that facilitate or hinder PIs' engagement in safety leadership

Two main strategies to develop PI leadership competencies that emerged from the interviews were "informal development" and "opportunities for exchange and reflection". There was an emphasis that PI leadership is developed informally through "trial and error". Informal mentorship and making a conscious effort to learn from experiences were reported as important methods for such informal development. However, while there was a strong focus on informal development as most suited for PI leaders, alongside this was recognition that this does not necessarily transfer to best practice and is to some degree haphazard. For example, PIs described themselves as "lucky" to have received guidance from senior colleagues.

Views regarding formal development were mixed. Some PIs were sceptical whether formal training would be effective at all for PI development. Others highlighted that any formal development would need to be delivered by academics themselves or individuals who have experience of the academic environment. Findings also indicated a need for exchange and reflection on leadership in the PI role. PIs commented that they had limited insight into how others approach the PI role and that it would be useful to share experiences with other PIs. Some PIs noted that prior to the interview they had not systematically thought about leadership in the PI role, and that the opportunity to reflect had brought about useful realisations about their own leadership approach. Overall, there was a higher-level theme of "learning from academic peers" – either through informal development or more formal methods that are delivered by academic colleagues.

With regards to safety leadership specifically, PIs expressed that the research environment was very different to industry sectors. PIs described how the application of health and safety is less strict in the higher education sector compared to private industry sectors. A small number of PIs discussed that a degree of risk is required for research to take place. Perceptions that higher education is distinct from industry with regards to safety could normalise the acceptance of lower safety standards and be an important hindrance for PIs engaging in safety leadership.

Table 4. PI development

Theme	Sample quotation
Prevalence of informal development	**A. Informal training as most suitable** *"Like anything in academia, we're not taught to teach, we're not taught to be managers, we're not taught to be leaders. So you have to go out and you have to work it out yourself. Which I suppose is a nice thing because then you can decide how you want to develop yourself. But nobody tells you what to do."* *"I was lucky because the senior colleague I was working with is very supportive and has got a…has a very nice touch to how he develops younger staff. So I was lucky. But I could see that other members of staff, new members of staff, were not so lucky. So I was very fortunate to be able to interact very closely with my line manager and mentor in this. So I think the new academics course would probably repeat what I did with my line manager, so this is everything from recruitment through to actually managing individuals and characters in trying to get the best out of them and how to deal with really difficult situations."* **B. Recognition of limitations of informal learning** *"To encourage someone doesn't mean that you are giving the skills - that's very different, alright, so someone can say, okay [name omitted], let's try, be the PI, you should be able to experience. That's great and certainly it's an experience, but that doesn't mean that they are transferring their skills, they are just giving you the job. […] There is no culture, neither any structure to really train people in those roles as far as I'm aware, at least in our school."*
Formal training through academic peers	*"I've seen too many cases where there were people trained to deliver these courses and so on, but they don't have any real understanding of what the academic situation is and it becomes a very hypothetical, almost meaningless exercise which just turns off the academics. And if that happens once early on in somebody's career, it's very difficult to draw it back later on. So I think having people leading those who are appropriately trained, yes; but that they understand the academic situation, the courses are planned with academic input as to these are the key issues that we should be addressing."* *"I got enrolled on a […] on an external leadership programme a few years ago - [name omitted] – and it was dreadful because it was effectively something that was aimed at industry and it just wasn't really kind of fit."*
Opportunity for exchange and reflection	*"I suppose I don't know whether I'm doing good leadership or not, so there might be an issue there of not knowing what I'm doing. I hope I'm doing as good a job as I can. But I don't know whether I'm doing good leadership or not. […] I'd be quite curious to see what other people that you've spoken to have said."*
Uniqueness of the research environment v industry	*"In universities application of health and safety are a lot less strict than they are in industry in this country ..."* *"There obviously are regulations and handbooks but nobody is really policing that I don't think, in the same way as they would in… So they'll be obviously responsible for safety in a laboratory or whatever but there's nobody constantly scrutinising what people are doing and checking on it, so I think there is quite a strong differential [to industry]."* *"It [safety] can be seen as the overriding important one in certain circumstances but you do have zero activity if you have zero risk and that's the other side of the coin. So it's getting that."* *"I would like to think – well, hmm. I'm not sure the terms responsible and research sort of fit together very well."*

Results: survey study

As outlined above, the data collection for the survey yielded a small sample size of 32 PIs and 16 research group members, which is too small to produce robust results. It was therefore decided not to proceed with the analysis of the survey results at this stage, as any results would be tentative and based on a limited sample that might not be representative. It is planned to try to increase the sample size in the future.

However, the experienced difficulties in obtaining participation in itself presents a relevant outcome of the project. The low response rate indicates that online surveys might not be a suitable method to obtain meaningful data from the PI group. The intensification of academic workload has been discussed (eg Kinman, 2008; Kinman and Jones, 2008), and this might prevent academics from engaging in any additional activities such as an online survey. In particular, an online survey might be perceived as an administrative task that offers less stimulation or opportunity for self-reflection compared to taking part in an interview with a researcher. ■

03 Resources and tools

Throughout the project, we presented interim findings of the research to various stakeholder groups. We also developed a web-based presentation that summarises the research outcomes in an engaging and easily comprehensible way. All presentations can be accessed via the links provided below.

Table 5. Project resources and tools

Resource	Description and link
PI Safety Leadership Tool (Microsoft Sway)	This Microsoft Sway provides an engaging summary of the key findings based on the PI interview study and provides links to further scientific sources on safety leadership. The Sway was developed as a resource for PIs as well as to be used as a communication tool to disseminate the project findings with other stakeholder groups. The Sway can be accessed here: **https://sway.com/3uqiJeOO3cbpSeKS**
Project poster: 'Morning Campus' – Waking-Up Higher Education Institutions to Safety Leadership	This poster was presented at the British Psychological Society – Division for Occupational Psychology Conference and was also distributed as a link to all Universities Safety and Health Association (USHA) members as a project update. The poster can be accessed here: **https://figshare.com/s/d6ceec4766782e3ba99f**
Presentation: Principal Investigators as Safety Leaders	The presentation delivered at the USHA conference in Manchester in October 2015 discussed preliminary project findings. The slides can be accessed here: **https://figshare.com/s/6c3ebac3b6af1da642ab**
Presentation: How Leaders Shape Safety in Research Environments	The presentation delivered at the Asian Conference on Safety and Education in Laboratories (ACSEL) in July 2016 gives an overview of the safety leadership literature and makes recommendations how PIs can positively influence safety within their research groups and institutions. The slides can be accessed here: **https://figshare.com/s/cc828328a82eb7352dd6**

04 Recommendations

The findings from the PI interview study have generated recommendations for institutions on the implementation of PI safety leadership development programs, and provide guidance for PIs themselves on how to effectively promote safety (Table 5).

Table 5 (continued). Project recommendations

Proposal outcomes	Key points
Recommendations for policy on developing PIs' safety leadership and enhancing PI engagement in safety	Evidence from PI interviews suggested that: • An emphasis should be placed on informal development for leadership and safety alongside formal development. • Development should include a peer-to-peer approach. • Opportunities for PIs to exchange with each other and reflect on their approach to leadership in the PI role should be facilitated.
Recommendations on overcoming factors that might hinder PIs' engagement in safety leadership	Based on the PI interviews the following strategies were identified: • Making safety matters specific to research areas especially areas where risk is low to moderate or high risk activities are rare. • Framing safety as an ongoing, active initiative and creating positive goals rather than focusing merely on prevention of negative outcomes. • Learning from high-reliability industries; demonstrating that safety is a core value in higher education as it is in parallel industry sectors.
Guidance on best practice leadership behaviours that PIs can employ to improve safety within their research group and contribute to a positive safety climate in their institution	• Connecting safety and ethics to integrate safety more firmly into the overall research approach. • Exhibiting PI practices that demonstrate commitment to safety as a priority and normalise safety as a core, ongoing element in the research process: - Speaking about safety (eg including safety on the agenda of regular research meetings; bringing safety up in informal conversations). - Ensuring safety standards are met even in the face of competing demands. - Showing integrity and role modelling (eg leading by example and acting safely; matching words with deeds). - Engaging others in safety activities. - Showing recognition for safety performance and initiative for safety.

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Appendices

Appendix 1: PI interview schedule

Safety Leadership Interview Schedule – Principal Investigator

Introduction

Introduce self
Introduce research purpose:

- Interested in understanding leadership at the PI level and factors that help or hinder PIs to engage in effective leadership. We will start off general and then I will ask questions with regards to specific leadership goals.
- Funded by the Leadership Foundation

Use of data:

- Data will be used for a report for the Leadership Foundation, dissemination (conferences, paper, online with Leadership Foundation) and workshop.

Anonymity and Recording:

Voice recoding and verbatim transcriptions. Any quotes that we will use will be anonymised.

Information Sheet and Consent

Interview Questions

1. To start, can you tell me about a recent or past project where you are or were PI.

- Type of research / science / discipline
- Size of research team
- Length of project
- Level of experience

2. In your opinion what defines good PI leadership?

- What behaviours are important to lead a successful research team? What actions make a good PI?
- What competencies does a good PI need?
- Can you think of a particularly successful research project. What did you/the PI do to make the research successful?
- Can you think of less successful research project/ a project where things went wrong? To what extent contributed your/ the PI's leadership to the issues? How did you/ the PI turn the project around? What PI actions were important in recovering the project?

3. In your opinion what defines good PI leadership for responsible research?

- Interpretation of responsible research
- PIs' contribution to responsible research, Type of PIs' actions or behaviors for responsible research

4. If safety has not been discussed: I would now like to move on to the topic of safety within a research environment.

- To what extent is safety salient in your discipline / type of research that you do?
- As PI, to what extent are you involved in influencing safety within the research team? How do you do this?
- Can you describe the type of behaviors that you use to improve the teams' engagement in safety matters? What PI actions are important for driving safety?

5. Can you give an example of a project where there was a safety issue? What did you/ the PI do?

6. What factors help PIs to engage in good leadership for safe research?

- What factors make it difficult for PIs to engage in good leadership for safe research?

8. What are the most important development needs of PI?

- Thinking about the competencies you mentioned at the beginning of the interview, how did you develop these? How did you learn the PI role? What about safety leadership?
- Do you try to develop early career researchers to acquire competencies needed for the PI role? How do you do this?

Closing

- Is there anything else that you would like to comment that we have not covered yet?
- Do you have any questions for me/ us?

Debrief

- Thank for time.
- Link to demographics questionnaire.
- Offer invitation to workshop attendance.

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